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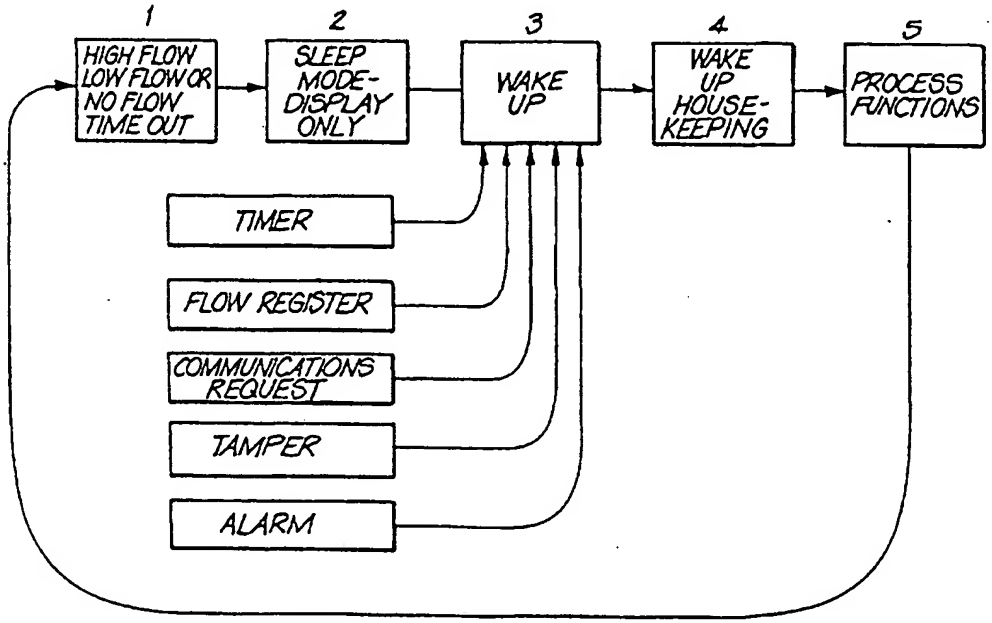
(54) Title: GAS METER WITH LOW POWER CONSUMPTION MODE



(57) Abstract

An electronic gas meter for measuring gas consumption by premises has one or more low power consumption modes. The gas meter switches to a lower-power consumption mode (2) in response to a predetermined number of gas flow measurements (1) below a set value. The gas meter is actuated to a higher power consumption mode (4, 5) in response (3) to a wake-up signal, an increased flow measurement, a change at a pressure regulator etc. Preferred embodiments include a power generation means generating power from the gas flow.

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GAS METER WITH LOW POWER CONSUMPTION MODE

BACKGROUND OF THE INVENTION

The invention relates to a gas meter of the type used for measuring gas consumption by a commercial or residential premises.

Gas meters of this type must be low cost, reliable and have a long life. Typically, such meters have mechanical gas flow metering and pressure regulating mechanisms, and as a result the meters are quite bulky. Gas meter readers are employed to visit the premises and note the meter readings periodically, from which the gas supply authority calculates the energy usage of the premises and bills the customer accordingly.

Electronic metering means are known per se, for example in Australian Patent No. 682498. However, commercially available electronic meters still have substantial limitations. One difficulty is that the metering means requires electrical power, which is normally provided by some form of battery. It would be desirable for a meter to include supplementary electronic components such as electronic regulators, pre-payment valves and additional sensing, calculating and communications functions. However, such extra features increase the power consumption of the meter beyond what is practical for the existing arrangements, and thus the presently available meters do not include these extra functions.

The invention aims to overcome at least some of these disadvantages.

SUMMARY OF THE INVENTION

The invention provides a gas meter for measuring gas consumption by a premises including a gas inlet, a gas outlet, electrically-powered gas metering means between said inlet and outlet, means sensing a reduced flow condition and switching the meter

to a low power consumption mode, and means sensing a high flow condition and switching the meter to a higher power consumption mode.

Preferably the meter includes means for periodically actuating said metering means to measure gas flow said periodic actuating means actuating said metering means at a first period between successive actuations when said meter is operating in said higher power consumption mode, and actuating said meter means at a second period between successive actuations when said meter is operating in said low power consumption mode, said second period being greater than said first period.

Preferably the meter operates in conjunction with a gas pressure regulator and is actuated from the low power consumption mode to the higher power consumption mode in response to a detected change at the regulator. Alternatively or in addition, the meter is actuated from the low power consumption mode to the higher power consumption mode in response to an increased gas flow measurement.

Preferably the meter can operate in first and second low power consumption modes, the first low power consumption mode corresponding to a low flow condition, such as a pilot flow, in which said metering means is actuated to measure gas flow at a second period greater than the first period between successive actuations, the second low power consumption mode corresponding to a zero flow condition in which said metering means is actuated to measure gas flow at a third period between successive actuations, said third period being greater than said second period.

More preferably the meter can operate in a plurality of low power consumption modes each having a respective period between successive actuations of the metering means, the meter being actuated from one low power consumption mode to a lower power consumption mode in response to a predetermined number of successive measurements of gas flow below a predetermined value.

A second form of the invention provides a gas meter for measuring gas consumption by a premises including a gas inlet, a gas outlet, electrically-powered gas metering

means between said inlet and outlet, electrical power generation means powered by the gas to produce electrical power, means sensing a reduced flow condition and switching the meter to a low power consumption mode, and means sensing a high flow condition and switching the meter to a higher power consumption mode.

Preferably, the power generation means is powered, directly or indirectly, by the flow of gas through the meter.

BRIEF DESCRIPTION OF THE DRAWINGS

Further preferred embodiments will now be described with reference to the accompanying drawings, in which:

Fig. 1 is a schematic showing the components in the gas meter/regulator unit;

Fig. 2 is a block diagram showing a first preferred operation of the meter functions in switching between operative modes; and

Fig. 3 is a block diagram showing a second preferred operation in switching between modes.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 1 shows a gas meter/regulator unit 10 having a gas inlet 12 for connection to a high, variable pressure gas supply, typically at 5-600 kPa, and an outlet 13 for connection to the gas plumbing of the premises for which the meter/regulator unit is installed.

Within the unit 10, the gas flow path is divided into a high, variable pressure region between the inlet 10 and a regulator 14, and a low pressure region downstream of the regulator. The regulator acts to reduce.the high gas supply pressure to a lower, substantially constant pressure at which the gas is supplied to the premises, typically in the range of 0.5-3.5 kPa. The regulator 14 may be mechanically operated, such as a conventional spring-biased valve, but preferably is electronically controlled by the processor/controller 16 or a combination of electronic and mechanical control.

Located upstream of the regulator 14 in the high pressure region of the gas path is an electronic metering apparatus 18, such as the type consisting of acoustic transducers situated at upstream and downstream ends of a gas flow measurement tube. The transducers are controlled by the processor 16 to periodically, for example every 1-4 seconds, transmit and receive acoustic (e.g. ultrasonic) signals through the tube. Variations in the time taken for the signal to traverse the tube or changes in the signal phase are used to calculate the gas flow velocity through the tube.

Further details of this preferred acoustic metering apparatus are described in Australian Patent No. 682498, the contents of which are incorporated herein by reference.

A pressure sensor 28 measures the gas pressure in the high pressure region and generates an output to the processor 16. The sensor 28 may also incorporate a sensor for measuring the gas temperature. The sensor is preferably situated in the gas flow path after the metering tube 18 and before the regulator 14. If an electronically controlled regulator is employed, the output value from the pressure sensor 28 may also be used as a control for the regulator.

The processor 16 receives the outputs from the metering apparatus 18 and, optionally, from any other sensors (not shown) and from this information calculates the gas flow quantity passing through the unit and into the premises. A cumulative quantity reading is communicated to a display 20 on the unit. The processor 16 may also be provided with an external communications link 22 allowing remote reading and control of the meter/regulator unit. For example, if an electronically controlled regulator is used, the unit may have facility for the gas supply authority to send a signal causing the processor 16 to close the regulator valve 14, shutting off the gas supply to the premises.

A power generation unit 24 is positioned in the gas flow path to produce electrical power from the gas flow through the meter. The generating units may be driven

directly by the gas movement, such as a turbine, or indirectly, for example by a thermocouple producing a voltage due to the gas temperature change across the regulator 14 or gas metering apparatus 18. Electrical power can also be generated by placing a coil and actuating arm in communication with a regulator valve. Oscillations of the regulator valve cause relative movement between the coil and arm, thereby generating a current.

The unit also includes an energy storage device 26, for example a high capacitance, low leakage "super" capacitor and/or a back-up Lithium battery, as stand by against failure of the power generating unit and for operation of the unit when the gas flow is zero. The power storage requirements of the storage device 26 are substantially less than for the batteries used in conventional electronic meters and therefore the device 26 can be smaller and cheaper than otherwise required.

Fig. 2 shows, in block diagram form, a first embodiment of switching the unit between a low power consumption mode and normal operative mode.

With the unit operating initially in its normal operative mode, the processor actuates the transducers of the metering apparatus 18 to send an acoustic signal on average every 2 seconds to measure the gas flow and controls the other features and sensors of the meter unit.

Upon the sensing of no gas consumption for a predetermined time, for example 10-60 seconds, the processor 16 puts the unit into a lower power consumption mode in which the display and a timer operates but other operations of the unit are closed down. The acoustic signals sent between the transducers of the electronic metering apparatus are either discontinued entirely or sent at much-reduced regularity, for example 20 - 60 seconds. The 'no flow' condition may be sensed by the gas metering apparatus 18 or by the regulator 14 remaining closed for a predetermined time.

Another possible mode of operation is that of low gas usage, for example when only pilot burners are being operated. If this low flow condition is detected by flow below

a threshold value for a predetermined time, for example 10-60 seconds, the meter can operate in a reduced consumption mode where the regularity of the acoustic signals is reduced to save power until higher flow rates are detected.

The meter may have a range of low power consumption modes. If a low flow reading is recorded for a predetermined number of successive measurements, for example 10, the period between measurements may increase, for example by a preset amount or by doubling the measurement period. This can continue to occur, and the meter can operate in successively reduced power consumption modes, until a maximum measurement period is reached.

In these reduced consumption modes, the processor 16 remains alert to a wake up signal, being one or more of a communications signal from the gas supply authority, an alarm condition such as a tamper alarm, or detection of increased gas flow. The latter may be induced by detection of increased flow by the electronic metering apparatus (if operating), a change in gas temperature in response to gas consumption by the consumer, opening of the regulator, a change in voltage from the power generation means 24, or a reduction in pressure downstream of the regulator, in which case a piezo-electric or other transducer can be used to detect the pressure fluctuations. Small variations above and below the measured gas flow during the reduced consumption nodes that are insufficient to trigger a wake up signal will average out over the billing period.

Upon detection of the wake up signal, the processor may perform housekeeping operations such as downloading calibration data from non-volatile memory and updating the clock before switching on the full operative functions of the meter.

Fig. 3 illustrates a preferred embodiment in which the meter is put into sleep mode between successive metering signals, the period between signals being varied dependent on whether high flow, low flow or no flow conditions are detected.

In the normal, high flow operating mode the processor wakes up the meter upon detection of increased flow, a communications request, a tamper alarm or other alarms such as earthquake or excess flow alarms, or upon signal from the wake up timer. The processor then proceeds with its wake up housekeeping, downloading calibration data from non-volatile memory into RAM and updating the clock by adding the elapsed time stored in RAM to the stored time and date in the non-volatile memory.

The processor then instructs the various sensors in the meter to actuate, including the acoustic transducers which meter the flow velocity. This measurement is then compared against the high flow and low flow thresholds. If the measurement is above the high flow threshold, the wake up timer is set for a preset time, e.g. 1-4 seconds. When a low flow or no flow measurement is detected, the unit continues to set the wake up timer at the high flow timer setting until a predetermined number of consecutive low flow or no flow measurements have been recorded. After this number of low flow or no flow measurements is recorded, the wake up timer is then set at a low flow timer setting, e.g. 10-30 seconds, or no flow timer setting e.g. 20-60 seconds, respectively. The processor then puts the unit into sleep mode until it receives a wake up signal from the wake up timer or detection of any of the other wake up signals.

Preferably, the threshold value defining the high gas flow is sufficiently high for the power generating means to be producing enough power for full meter operations without drawing power from the storage device 26. As the gas flow is reduced, with corresponding reduction in power generation, the unit operates at a lower power consumption mode thus reducing the power drawn from storage device 26.

By providing the meter unit with power generating means and one or more low power consumption modes, more sophisticated functions can be incorporated into the meter while retaining the required longevity of the power supply. Features which may be incorporated include external communications capability, an electronic regulator which may act also as a prepayment valve, and recording of gas usage patterns, which can be used to allow charging on the basis of peak and off-peak gas usage.

While particular embodiments of this invention have been described, it will be evident to those skilled in the art that the present invention may be embodied in other specific forms without departing from the essential characteristics thereof. The present embodiments and examples are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

CLAIMS

1. A gas meter for measuring gas consumption by a premises including a gas inlet, a gas outlet, electrically-powered gas metering means between said inlet and outlet, means sensing a reduced flow condition and switching the meter to a first low power consumption mode, and means sensing a high flow condition and switching the meter to a higher power consumption mode.

2. A gas meter according to claim 1 further including means for periodically actuating said metering means to measure gas flow, said periodic actuating means actuating said metering means at a first period between successive actuations when said meter is operating in said higher power consumption mode, and actuating said meter means at a second period between successive actuations when said meter is operating in said low power consumption mode, said second period being greater than said first period.

3. A gas meter according to claim 1 wherein said means sensing a reduced flow condition includes means sensing a predetermined number of successive gas flow measurements below a predetermined value.

4. A gas meter according to claim 2 wherein said meter includes a second low power consumption mode in which said meter is actuated to measure gas flow at a third period between successive actuations, said third period being greater than said second period.

5. A gas meter according to claim 4 wherein said first low power consumption mode corresponds to a low gas flow condition and said second low power consumption mode corresponds to a zero flow condition.

6. A gas meter according to claim 2 wherein said meter can operate in a plurality of low consumption modes, each mode having a respective period between

successive actuations of the metering means greater than the period of the next higher power consumption mode.

7. A gas meter according to claim 6 wherein said meter is actuated from one low power consumption mode to a lower power consumption mode in response to a predetermined number of successive measurements of gas flow below a predetermined value.

8. A gas meter according to claim 1 wherein said meter is actuated from a low power consumption mode to said higher power consumption mode in response to a detected change at a gas pressure regulator.

9. A gas meter according to claim 1 wherein said meter is actuated from a low power consumption mode to said higher power consumption mode in response to an increased gas flow measurement.

10. A gas meter according to claim 1 further including electrical power generation means powered by the gas to produce electrical power.

11. A gas meter according to claim 10 wherein said electrical power generation means includes a turbine driven by the flow of gas.

12. A gas meter according to claim 10 wherein said electrical power generation means includes a thermocouple producing a voltage in response to a gas temperature change.

13. A gas meter according to claim 10 wherein said meter operates in conjunction with a gas pressure regulator including a regulator valve, said electrical power generating means including a coil and an actuating arm, one of said coil and arm being in communication with said regulator valve, said coil and arm generating electrical power in response to oscillation of said regulator valve.

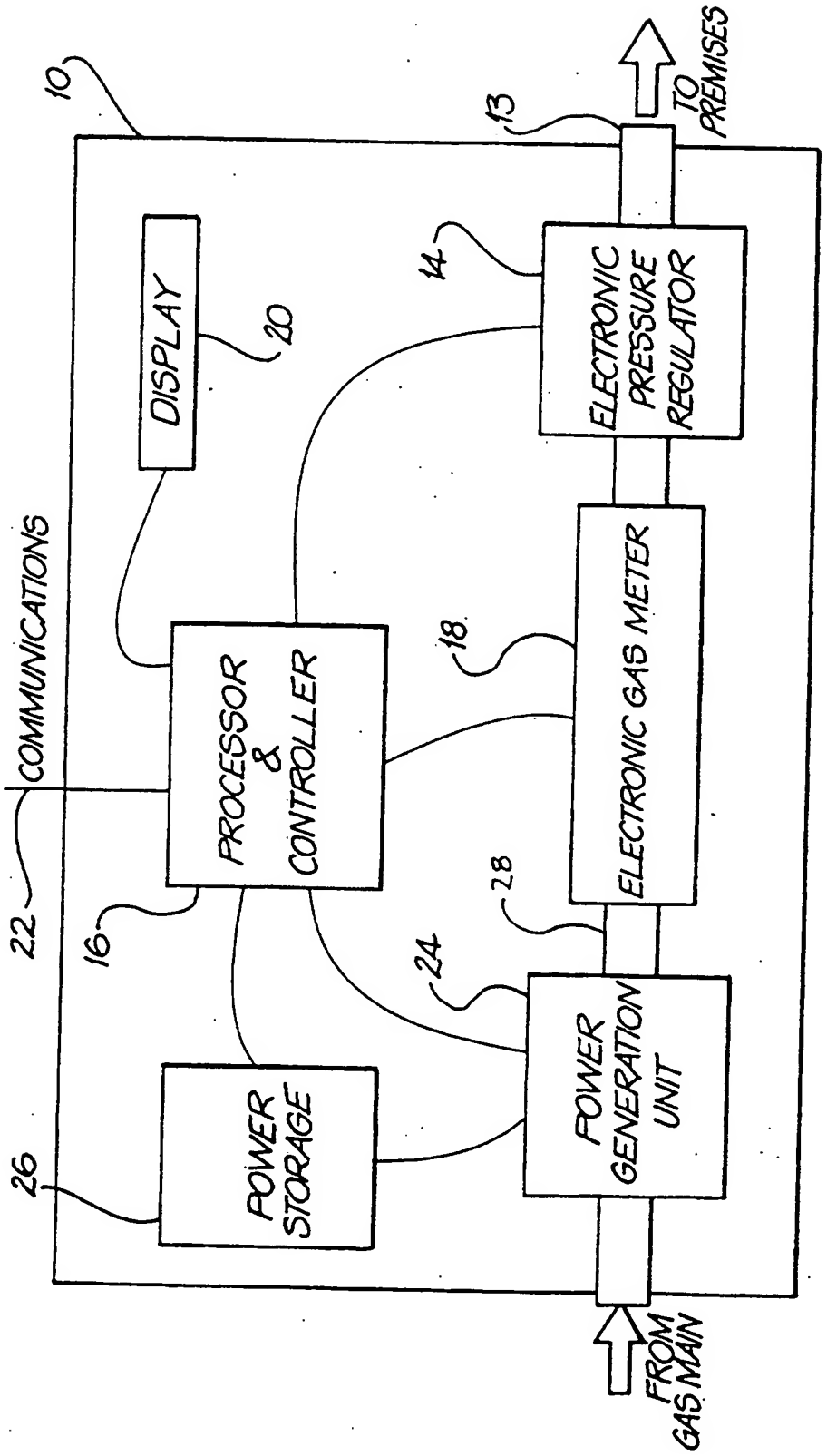
10
13
TO PREMISES
DISPLAY
20
14
ELECTRONIC PRESSURE REGULATOR
COMMUNICATIONS
PROCESSOR & CONTROLLER
18
ELECTRONIC GAS METER
22
16
28
24
POWER STORAGE
POWER GENERATION UNIT
26
FROM GAS MAIN

FIG. 1

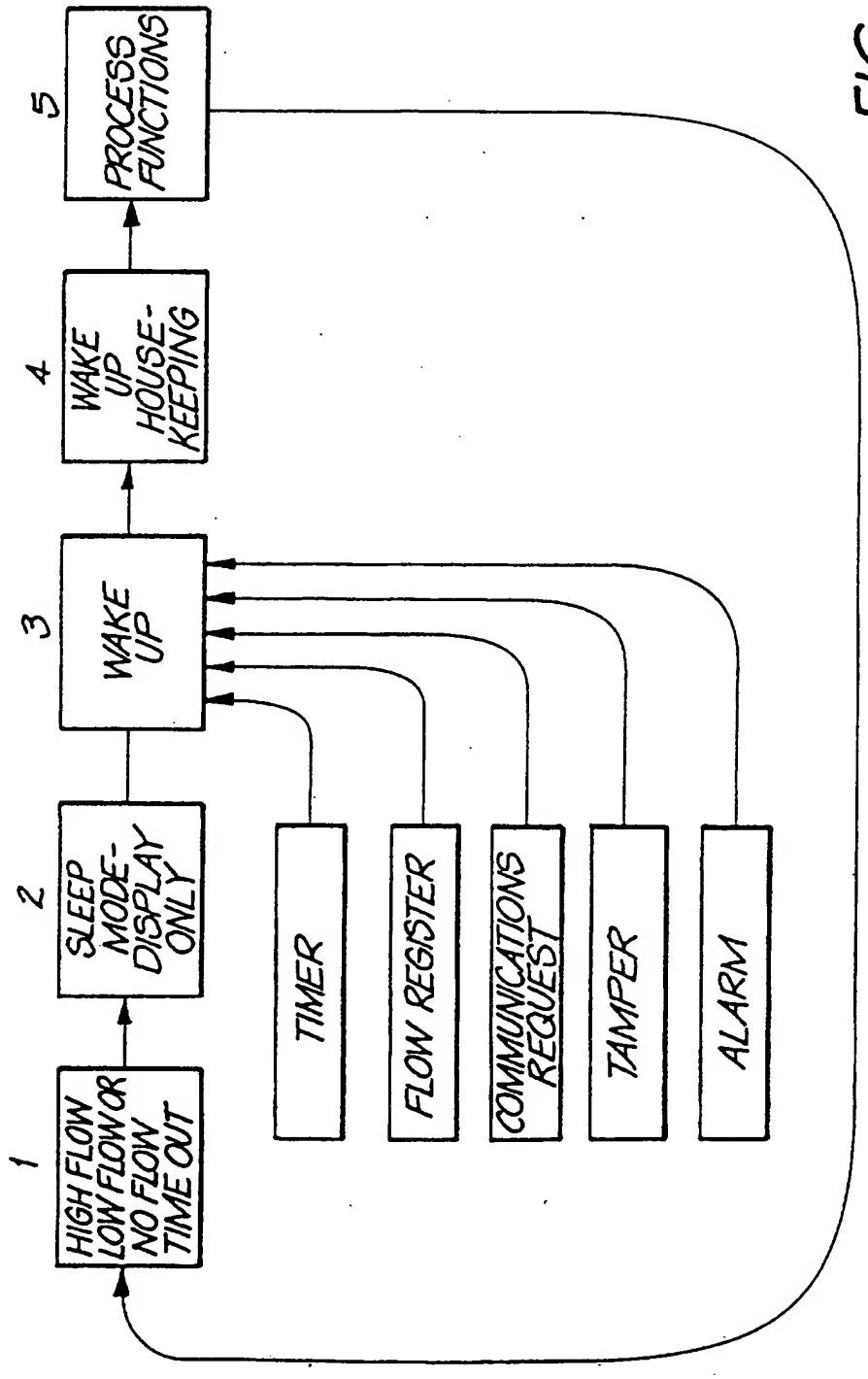
1
HIGH FLOW
LOW FLOW OR
NO FLOW
TIME OUT
2
SLEEP
MODE-
DISPLAY
ONLY
3
WAKE
UP
4
WAKE
UP
HOUSE-
KEEPING
5
PROCESS
FUNCTIONS
TIMER
FLOW REGISTER
COMMUNICATIONS
REQUEST
TAMPER
ALARM

FIG. 2

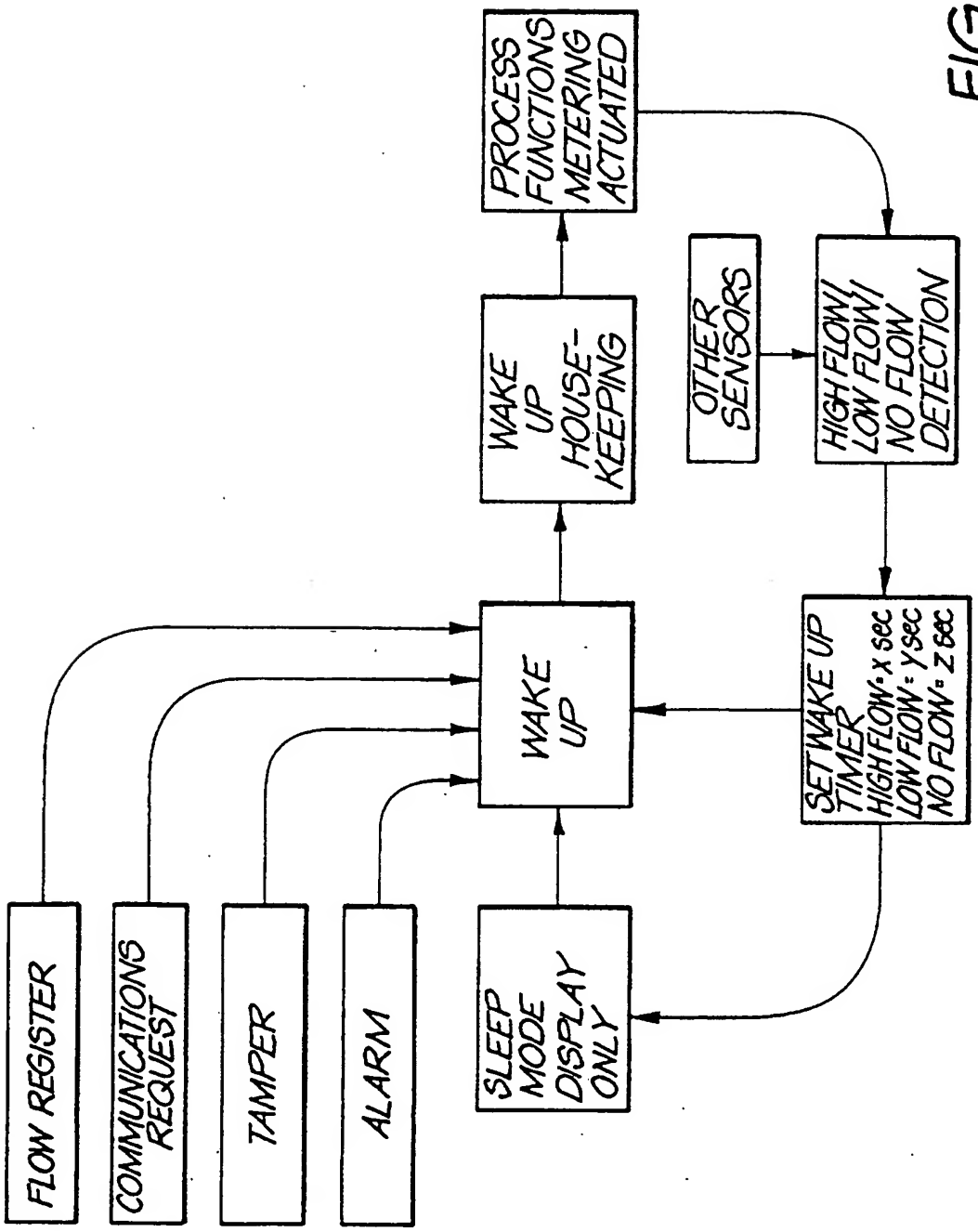
FLOW REGISTER
COMMUNICATIONS REQUEST
TAMPER
ALARM
SLEEP MODE DISPLAY ONLY
WAKE UP
SET WAKE UP TIMER HIGH FLOW = X sec LOW FLOW = Y sec NO FLOW = Z sec
WAKE UP HOUSE-KEEPING
OTHER SENSORS
HIGH FLOW/ LOW FLOW/ NO FLOW/ DETECTION
PROCESS FUNCTIONS METERING ACTUATED

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU00/00479

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: G01F 15/00, 15/06, 1/66 // G06F 1/32, H02J 7/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl. [7]: G01F 1/-, 15/-, 25/-

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DWPI, JAPIO, IFIPAT: Int. Cl. as above with search terms low, reduced, high, increased, flow, power, sleep, standby stand (W) by, meter+, gas, electric+, electronic, power (S) sav+, power (S) conserv+, low (W) power

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P, X	Derwent Abstract Accession No. 2000-003110/01, Class S02 & Patent Abstracts of Japan, JP 11-281429 A (YAZAKI CORP) 15 October 1999 Abstract	1 - 2
X	US 5251149 A (WILLIAMS et al.) 5 October 1993 Column 21, line 52 - column 22, line 38	1 - 6
X	US 4918995 A (PEARMAN et al.) 24 April 1990 Column 2, line 67 - column 3, line 14	1 - 2

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

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Date of the actual completion of the international search	Date of mailing of the international search report
7 June 2000	23 JUN 2000
Name and mailing address of the ISA/AU	Authorized officer
AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	RAJEEV DESHMUKH Telephone No : (02) 6283 2145

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU00/00479

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	US 5747703 A (PLISSON et al.) 5 May 1998	
X	Column 10, lines 7 - 14	1 - 2
	Derwent Abstract Accession No. 96-345116/35, Class S02 & Patent Abstracts of Japan, JP 08-159824 A (KANSAI GAS METER CO LTD) 21 June 1996	
X	Abstract	1 - 2
	US 5481259 A (BANE) 2 January 1996	
X	Column 2, lines 13 - 33	1 - 6
	US 4829449 A (POLESNAK) 9 May 1989	
X	Column 9, lines 16 - 32	1
	US 4799169 A (MIMS) 17 January 1989	
X	Column 6, lines 29 - 38	1

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU00/00479

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
JP	11281429	NONE					
US	5251149	NONE					
US	4918995	NONE					
US	5747703	WO	9516189	EP	734510	PL	314851
		SK	724/96	CA	2178503	CN	1141077
		FR	2713760	HU	76506	TR	28272
JP	8159824	NONE					
US	5481259	AU	23669/95	CA	2187188	EP	758475
		WO	9530217				
US	4829449	AU	67683/87	AU	34519/89	AU	34520/89
		EP	236681	JP	62191721	NZ	219058
US	4799169	NONE					

END OF ANNEX